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A Developmental Analysis of Behaviors Related to the Mirror Neuron System in 6-24 Months Infants

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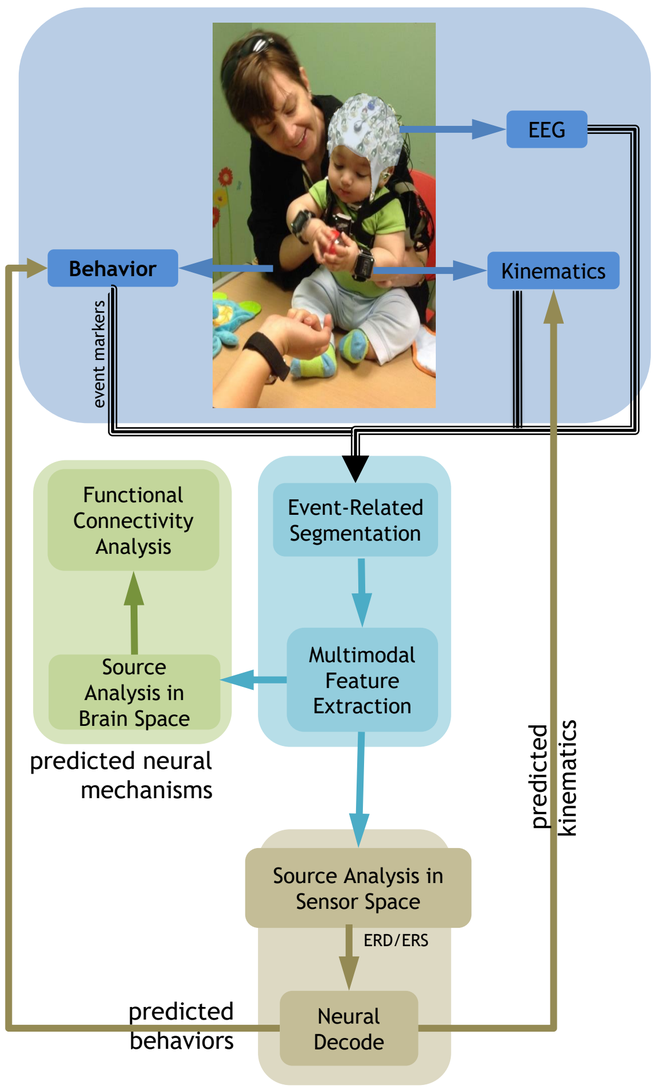
INTRODUCTION

It has been proposed that a mirror neuron system (MNS) may help explain how humans interact and learn by imitating others. However, little is known about the emergence of the MNS during development. Moreover, many developmental studies that focus on the MNS do so in constrained environments that do not necessarily reflect the daily activities of infants at home or play. In this study we present behavioral data gathered using mobile brain-body imaging of infants engaging in freely behaving interactions with an experimenter. Here we focus on finding an empirical baseline of age-specific behaviors that relate to the emergence of MNS actions.

METHODS

- Experimenter interacts with infants by engaging in unscripted social interaction.
- Each infant's age ranged from 6 to 24 months.
- 77 healthy infants were recruited (41 F, 36 M).
- 50 infants were successfully instrumented and tested (29 F, 24 M).
- Data from 27 subjects were discarded due to lack of cooperation by the baby (18), data loss (3), premature age (5), amplifier malfunction (1).
- A 64-electrode active EEG-cap was used to record brain activity and inertial measurement units monitored bodily movements.
- Figure shows study design.



BEHAVIORAL TASK

Rest | Observe | Reach-Grasp | Imitate | Explore | Reach-Offer

- After each session, behaviors were visually inspected and segmented, and 5-6 classes were identified to be common among most infants.
- To reduce bias, two researchers performed the behavior segmentation independently.
- A third researcher compared the two segmentations, resolved any event marking conflicts, and consolidated the results.

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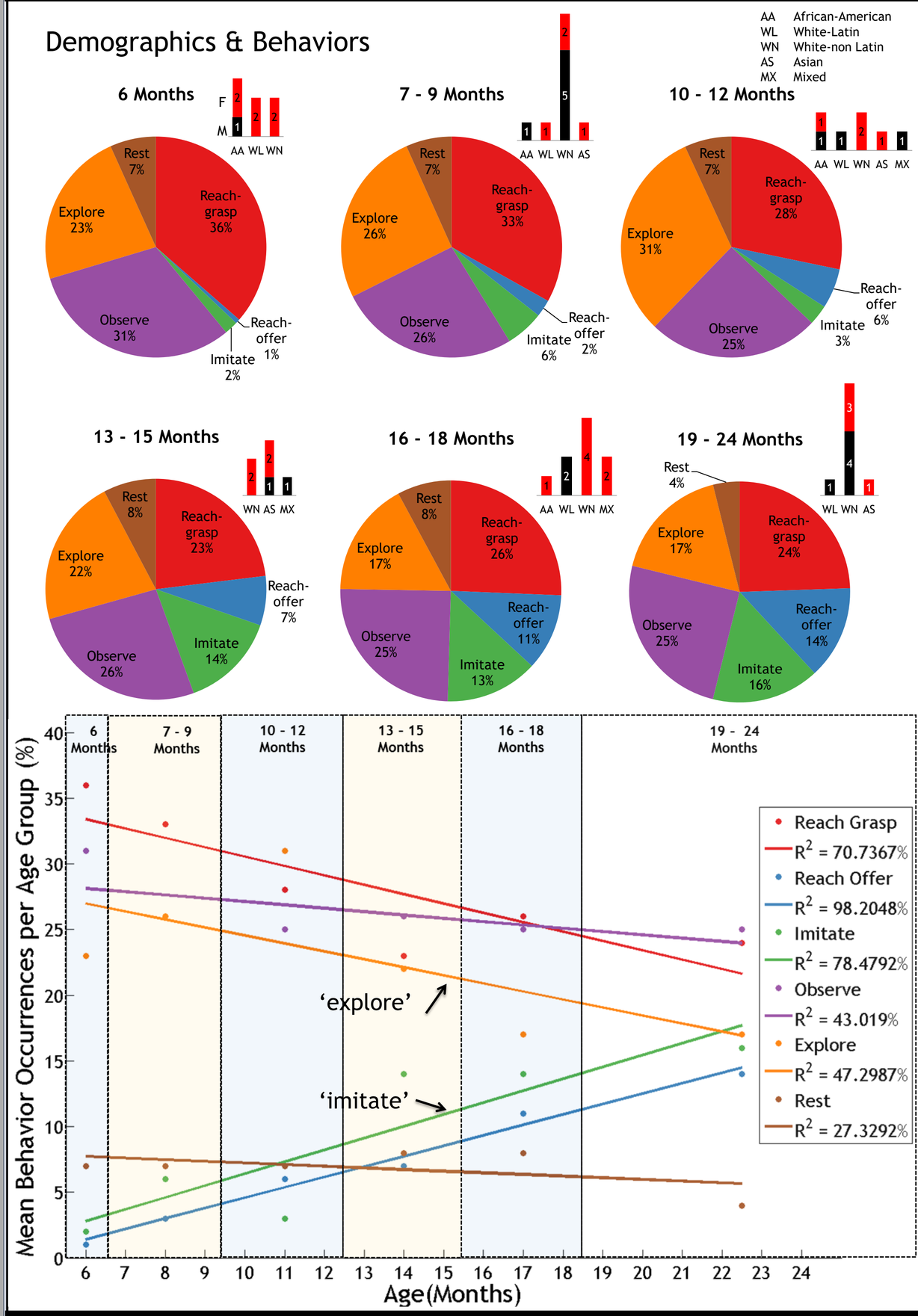
RESULTS



Discussion

- 'Explore' and 'Reach-grasp' are the main tasks performed by the youngest (6mo) infants. These skills are preserved during the infant's development, and other tasks such as 'Imitate' and 'Reach-offer' become more evident as development continues.
- The mean number of occurrences of 'Reach-offer' increases linearly with age (R^2= 98%), while for 'Imitation' there is a distinct increase from 10-12 to 13-15 months of age (R^2= 78%).
- Imitative behaviors are of particular interest because of the sharp increase around 12 months, thus suggesting a milestone in the development hypothesized MNS in human infants.
- In our broader analyses, we explore the neural biomarkers that characterize MNS development, and its milestones based on the empirical baseline reported here.
  - See, for example [1], [3], where our complete protocol and initial neural decoding results show the activation of neural patterns characteristic to the behaviors of interest.
  - Neuroimaging data and source analysis will be published elsewhere.
- We observed the infant's ability to interact with others since 6 months of age, in spite of the unfamiliarity with the surroundings, experimenter and the language barriers.

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